Wind atlas for Egypt. A national database for wind resource assessment and wind power planning

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Wind Atlas for Egypt

A national database for wind resource assessment and wind power planning

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- New and Renewable Energy Authority (NREA), Cairo

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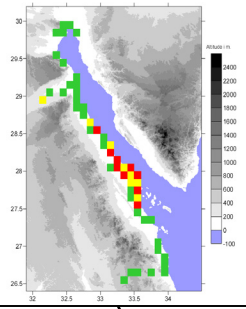
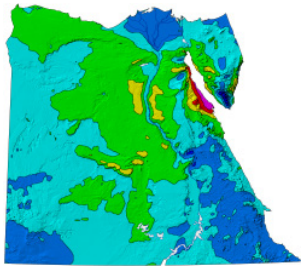
RISØ

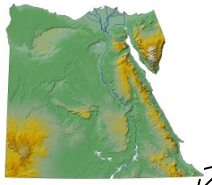
Bird Migration Atlas



Wind Atlas for Egypt



Maps etc.



§§

Legislation

Wind Farm Planning

Master plans

EIA

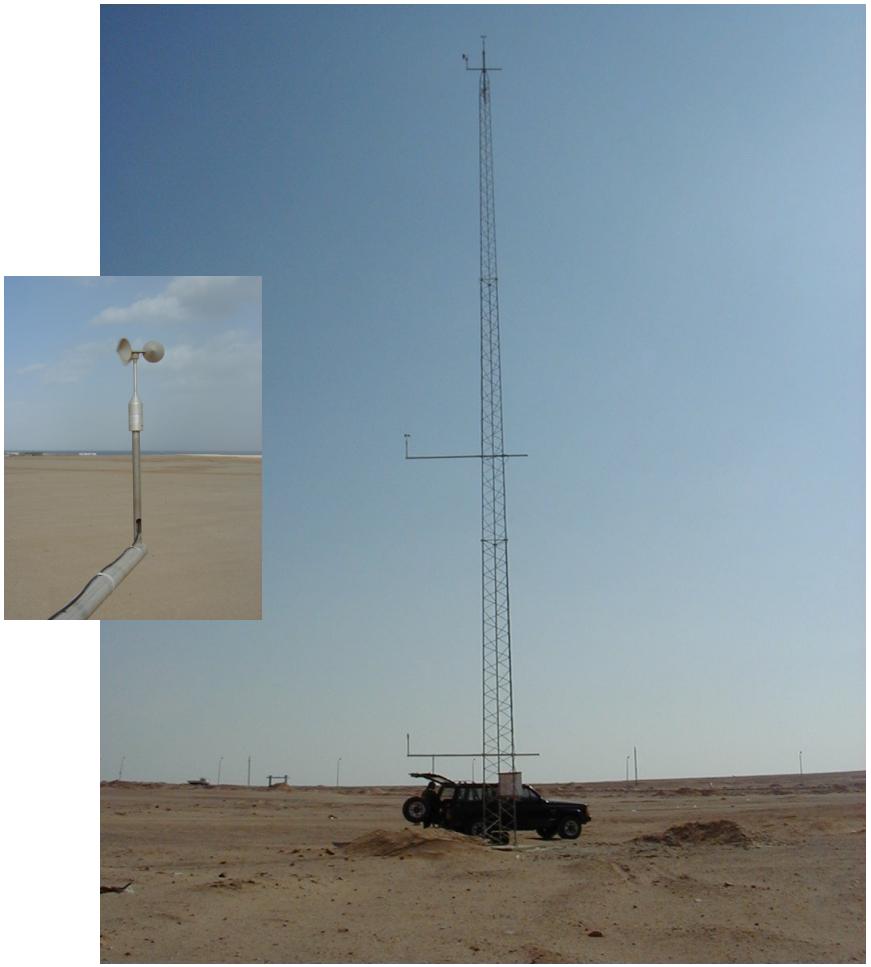
GUIDELINES

APPROVALS

Wind Atlas for Egypt overview

- Observational wind atlas
  - meteorological measurements
  - microscale modelling (WAsP)
- Wind resource mapping
  - reanalysis wind climatologies (NCEP/NCAR)
  - mesoscale modelling (KAMM)
- Numerical wind atlas
  - verification – measurements and models
  - Wind Atlas for Egypt book and CD-ROM
- Applications and future
  - planning, feasibility studies, project preparation
  - wind farm planning and annual energy production

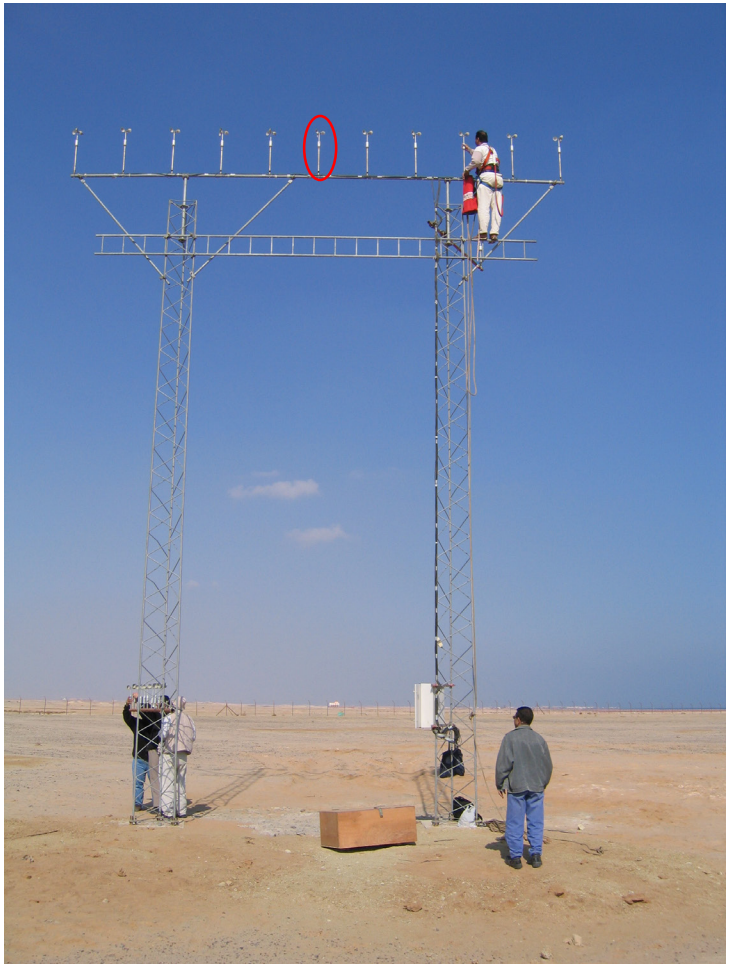
Sample meteorological mast in Zafarana



25-m lattice tower, concrete foundation

Top-pole mounting to avoid flow distortion

Hurghada Cup Anemometer Calibration Facility

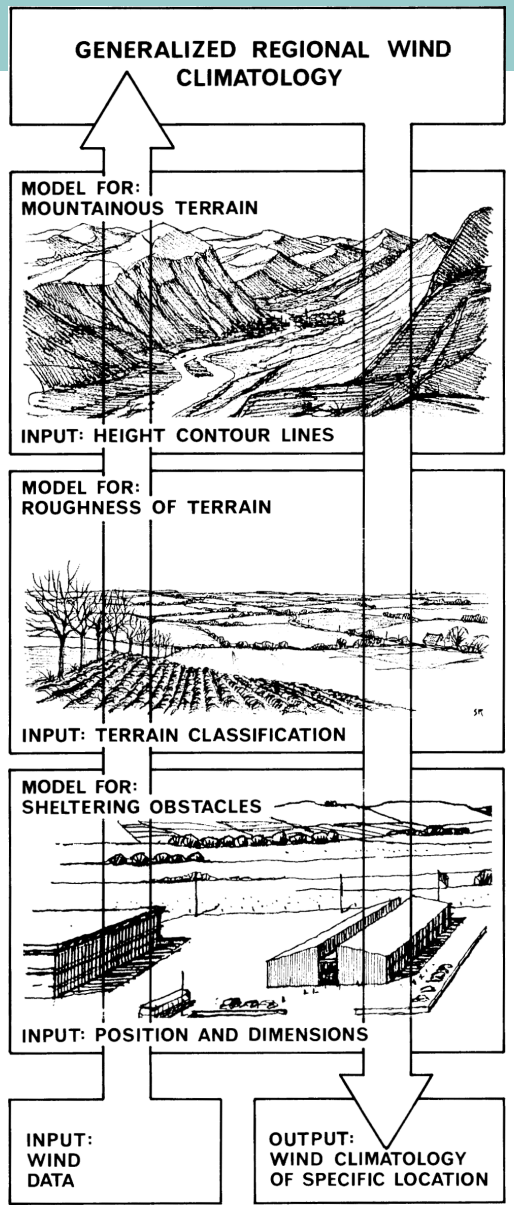


10 anemometers being calibrated – reference anemometer in middle position: ○

Observational wind atlas

- Analysis procedure ↑ (WAsP)
  Observed Wind Climate
  + sheltering obstacles
  + roughness map (GE, SWBD)
  + elevation map (SRTM 3)
  ⇒ **Regional Wind Climate**

- Application procedure ↓ (WAsP)
  Regional Wind Climate
  + sheltering obstacles
  + roughness map
  + elevation map
  ⇒ **Predicted Wind Climate**
  + power and thrust curves
  ⇒ **Predicted wind farm AEP**




Sidi Barrani
Sidi Barrani AP
El-Mathany
Ras El-Hekma
El-Galala
Alexandria
Port Said
El Arish
Katamaya
Google Earth - New Placemark
Ras Sedr
Abu Darag NW
Abu Darag
Zafarana M7
Zafarana
Nuweiba
Saint Paul
Ras Ghareb
Nabq
Gulf of El-Zayt NW
Hurghada WETC
Hurghada AP
Farafra
Kosseir (EMA)
Kosseir (NREA)
Kharga
Dakhla South
Asswan AP
Shark El-Ouinat
Shark El-Ouinat AP
Abu Simbel
N
W
E
S
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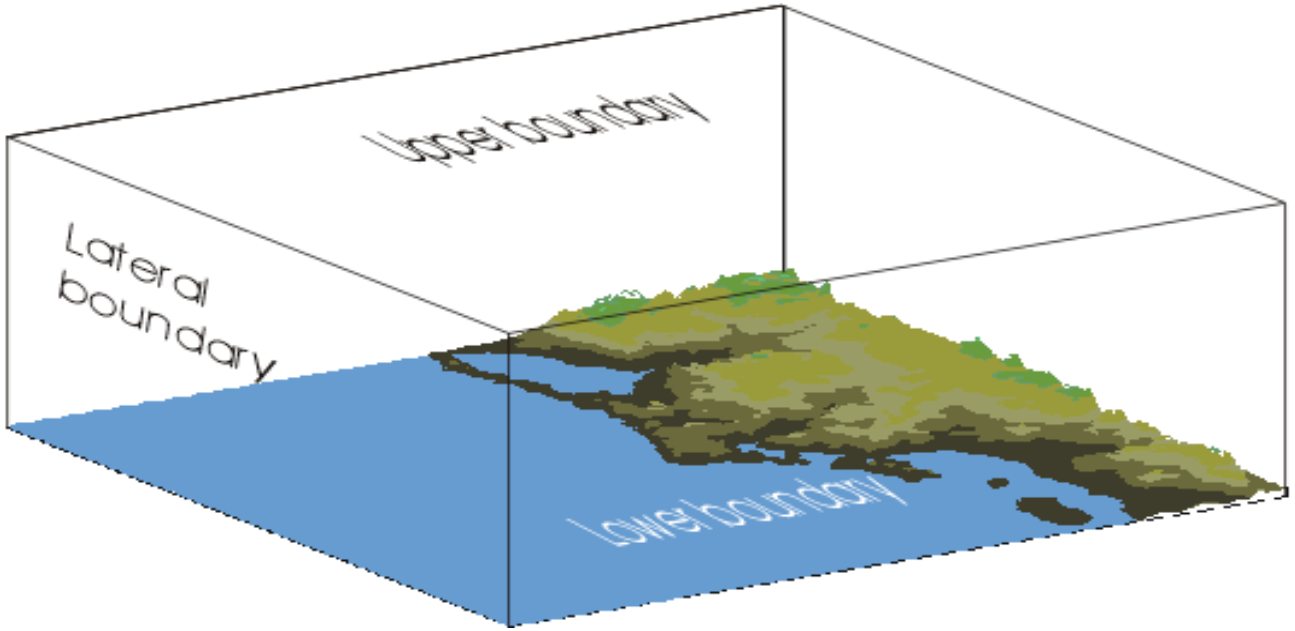
RISØ

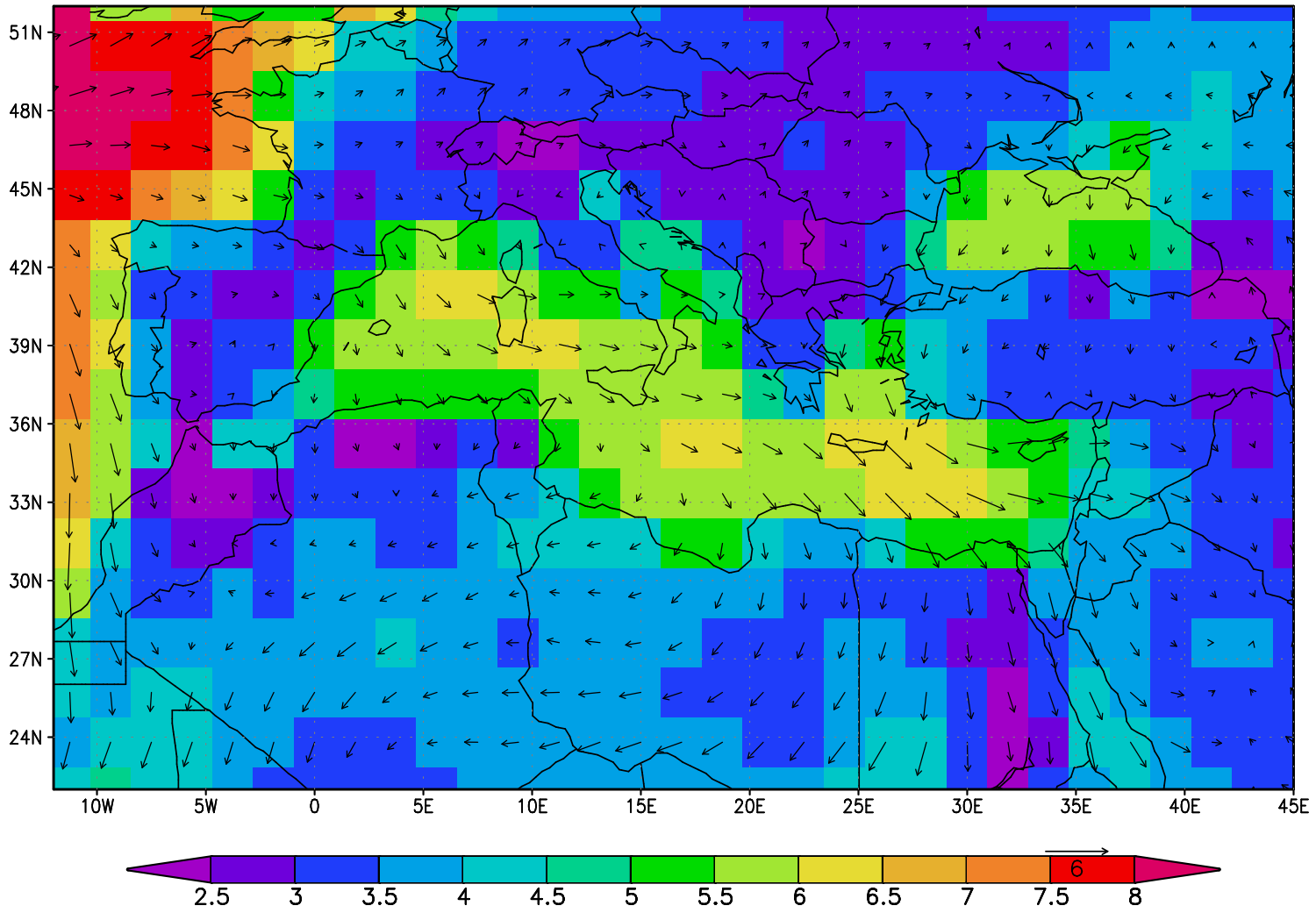
Wind resource mapping by modelling

- Mesoscale model
- Output: annual averages of wind speed and power
- Regular horizontal grid
- Area: 10,000-100,000's of km^2
- Resolution: 3-5 km

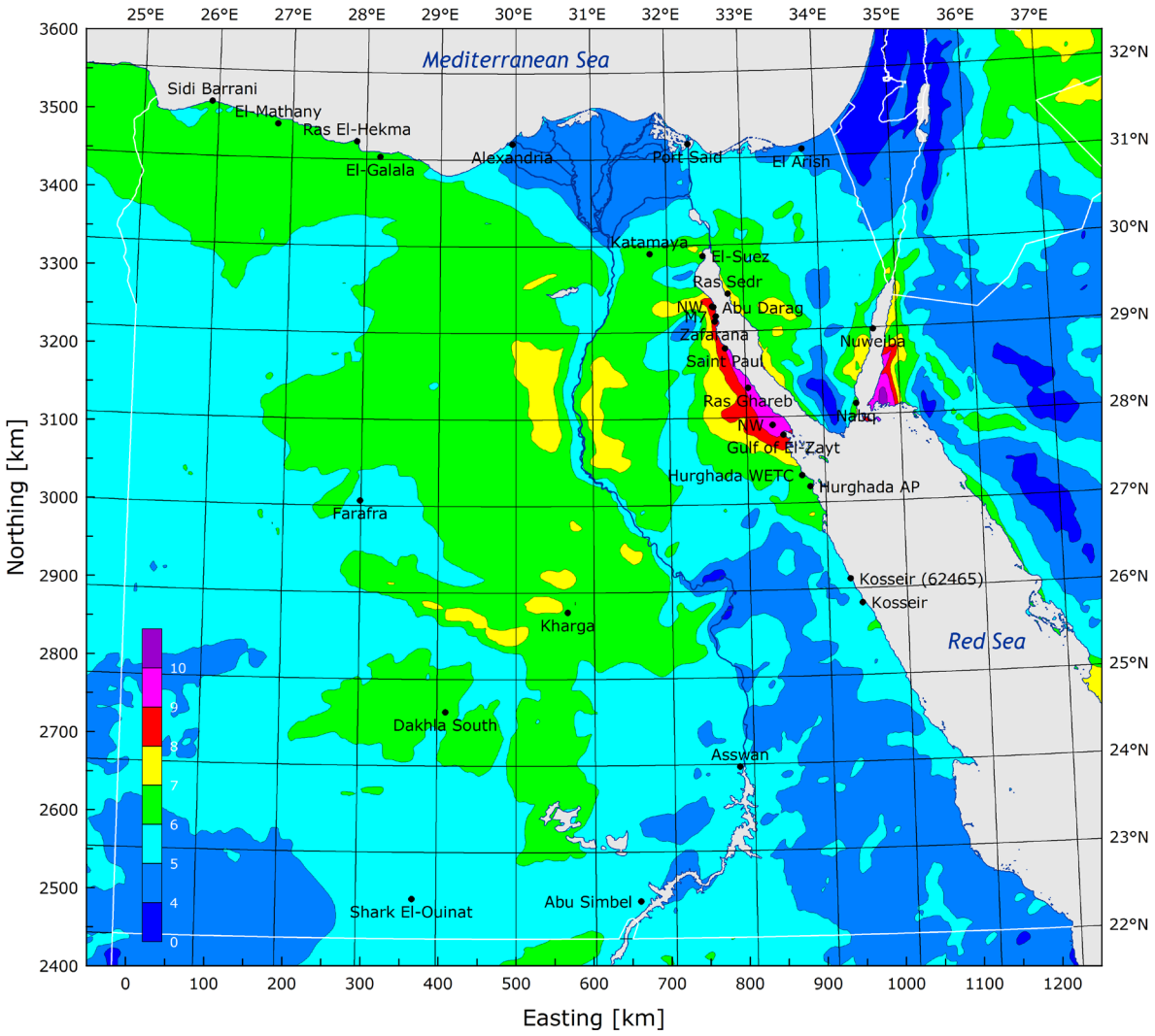
- Wind measurements are not required, but…
- Super-computer and skilled staff are needed!
- Uncertainty inherently larger than observational wind atlas



Regional winds from NCEP/NCAR reanalysis



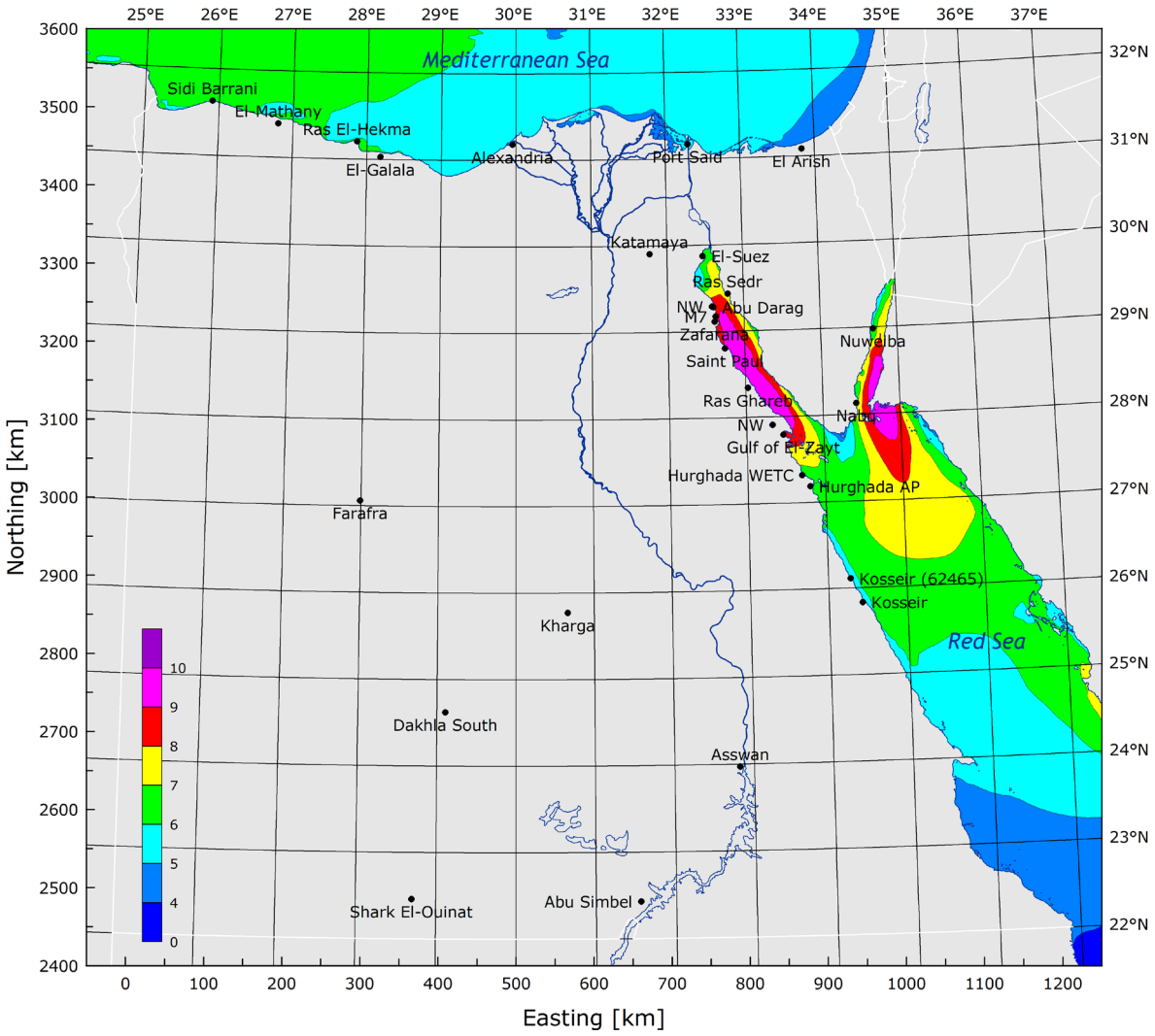
New wind resource map of Egypt



- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ms^{-1}]
- NCEP/NCAR data
- GTOPO30 elevation
- GLCC land cover
- Terrain features may give higher wind speeds locally!

- Output formats:
  - map graphics
  - statistics

…and Egyptian offshore wind resources

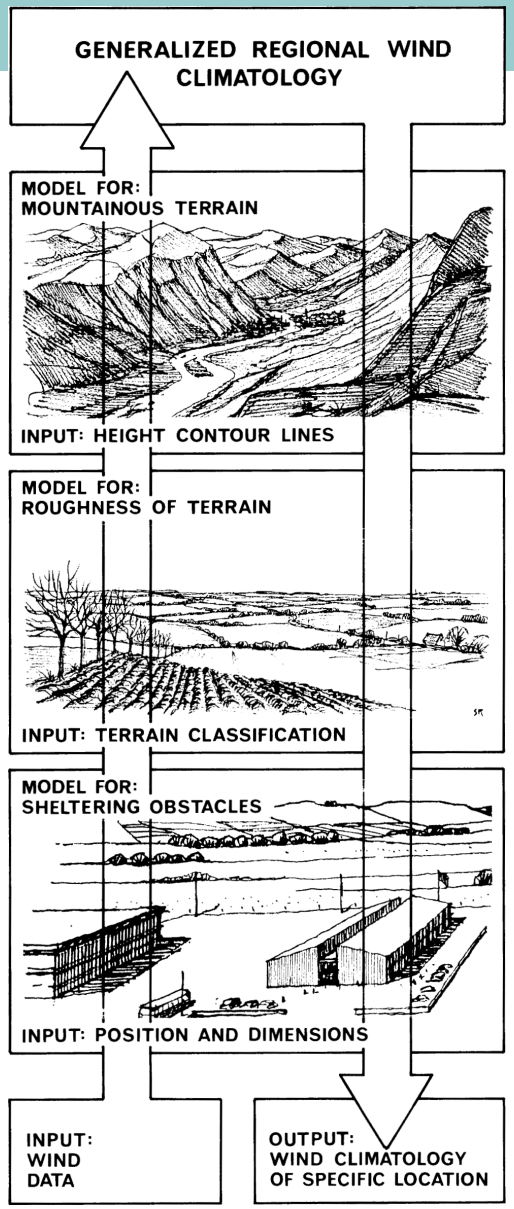


- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ms^{-1}]

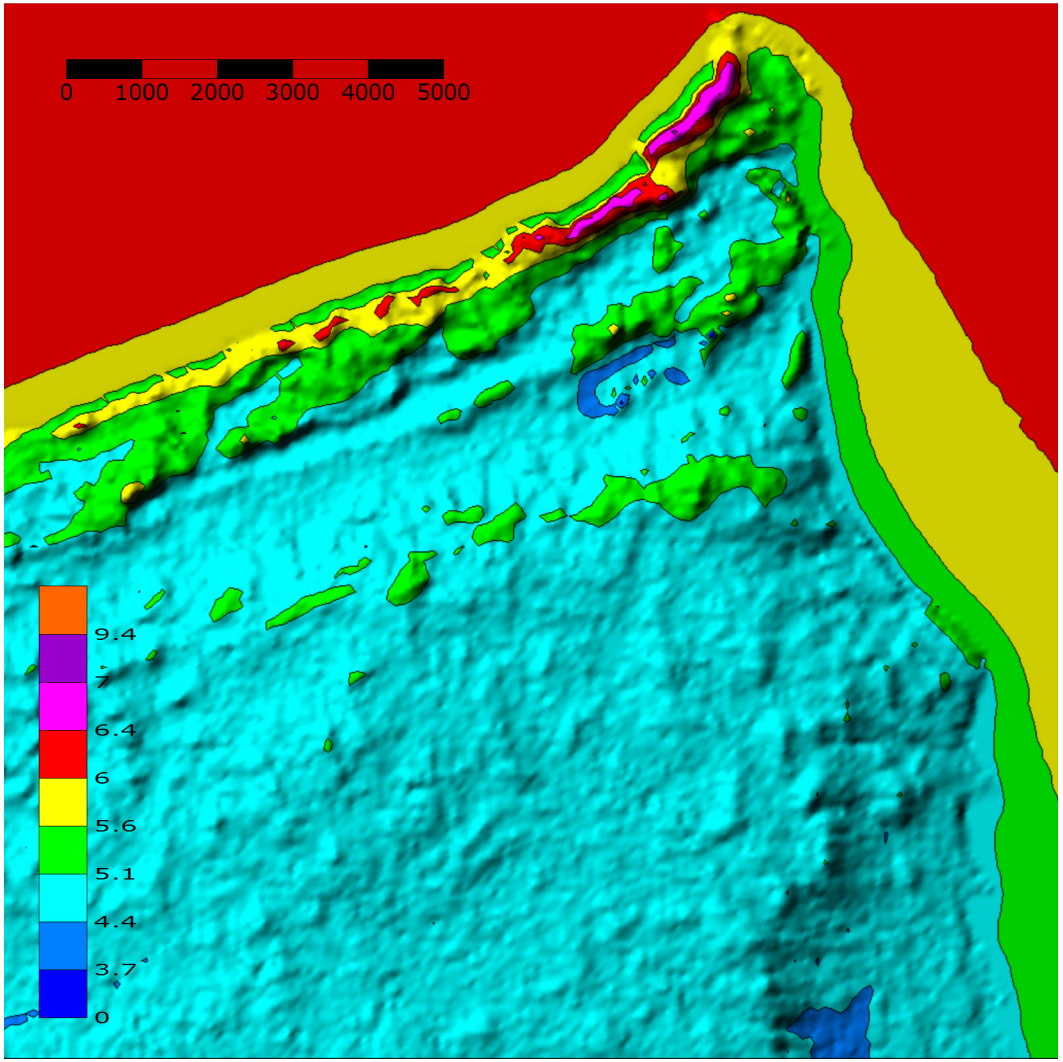
Numerical wind atlas

- NWA analysis procedure ↑ (WAsP-like)
  KAMM Predicted Wind Climate
  (> 50,000 virtual met. stations!)
  + roughness map (GLCC)
  + elevation map (GTOPO30)
  ⇒ **Regional Wind Climate**

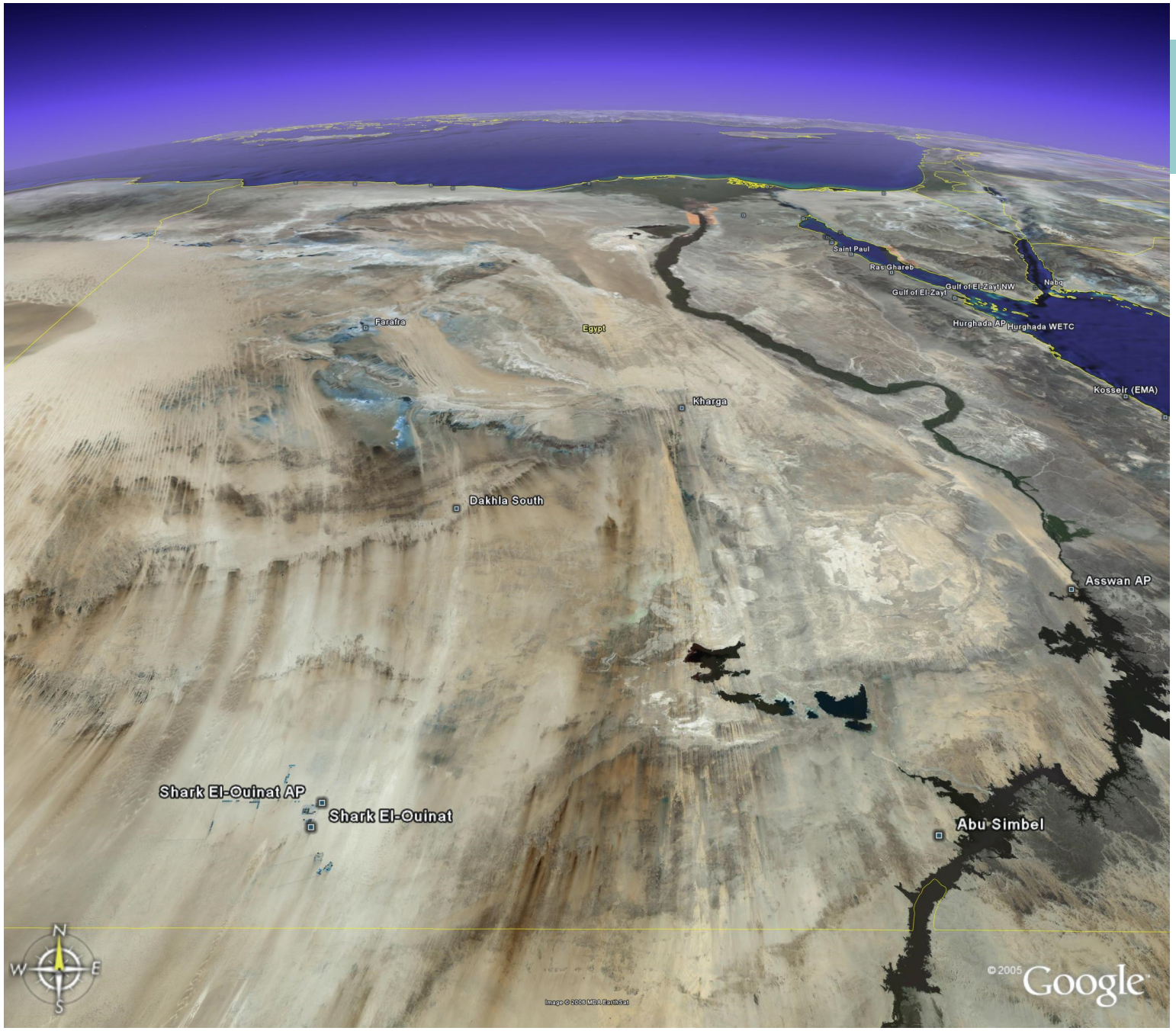
- Application procedure ↓ (WAsP)
  Regional Wind Climate
  + sheltering obstacles
  + roughness map
  + elevation map
  ⇒ **Predicted Wind Climate**
  + power and thrust curves
  ⇒ **Predicted wind farm AEP**



Detailed wind resources at Ras El-Hekma



- WAsP modelling of detailed wind speed @ 10 m a.g.l.
- Resolution 100 m
- KAMM wind map indicates Class 2
- Offshore resource is higher: Class 5
- Coastal resource is higher: Class 3/4
- Hill/ridge resource is higher: Class 6


Saint Paul
Ras Ghareb
Gulf of El-Zayt NW
Gulf of El-Zayt
Nabq
Farafra
Egypt
Hurghada AP
Hurghada WETC
Kosseir (EMA)
Kharga
Dakhla South
Asswan AP
Shark El-Ouinat AP
Shark El-Ouinat
Abu Simbel
N
W
E
S
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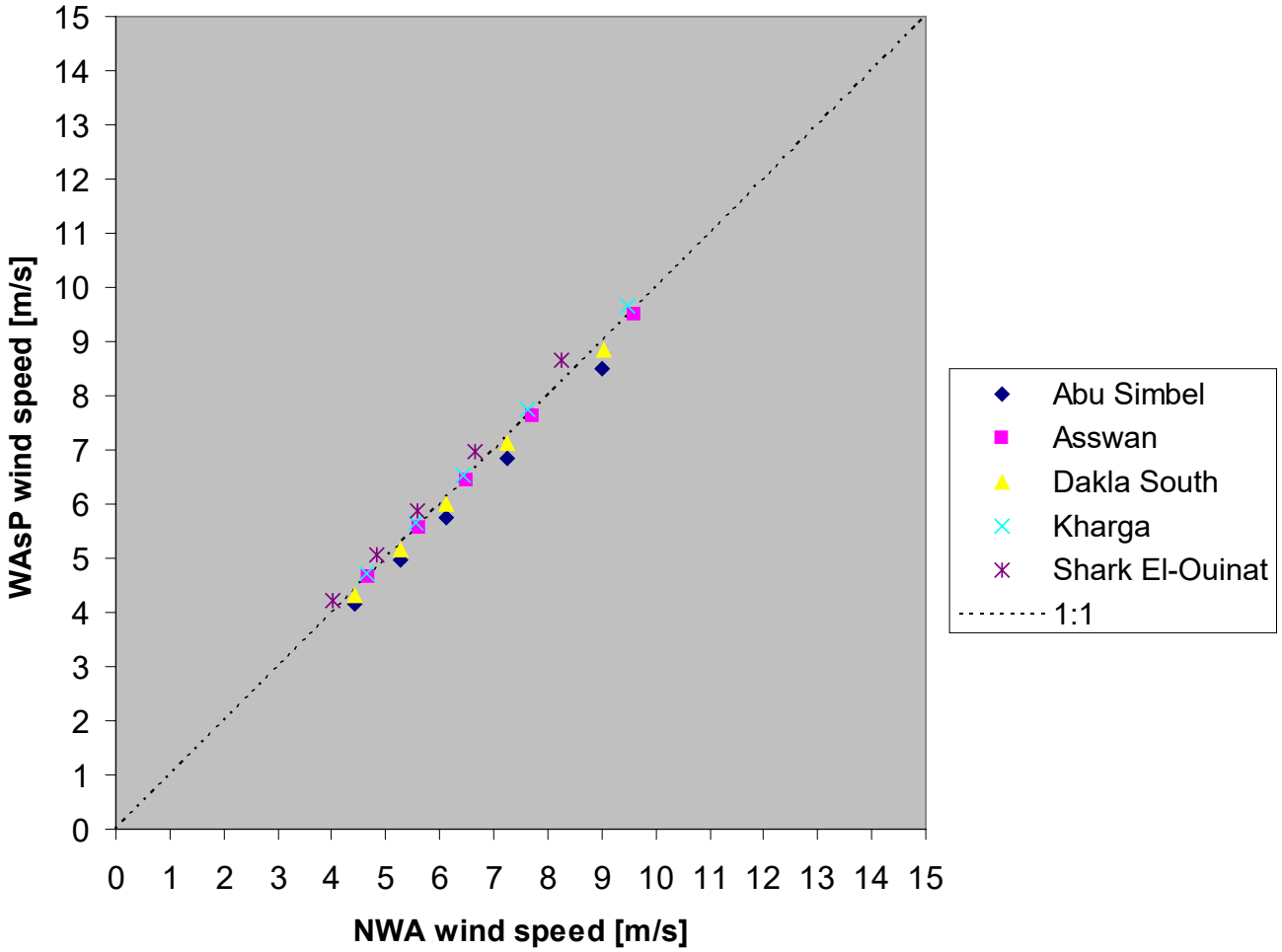
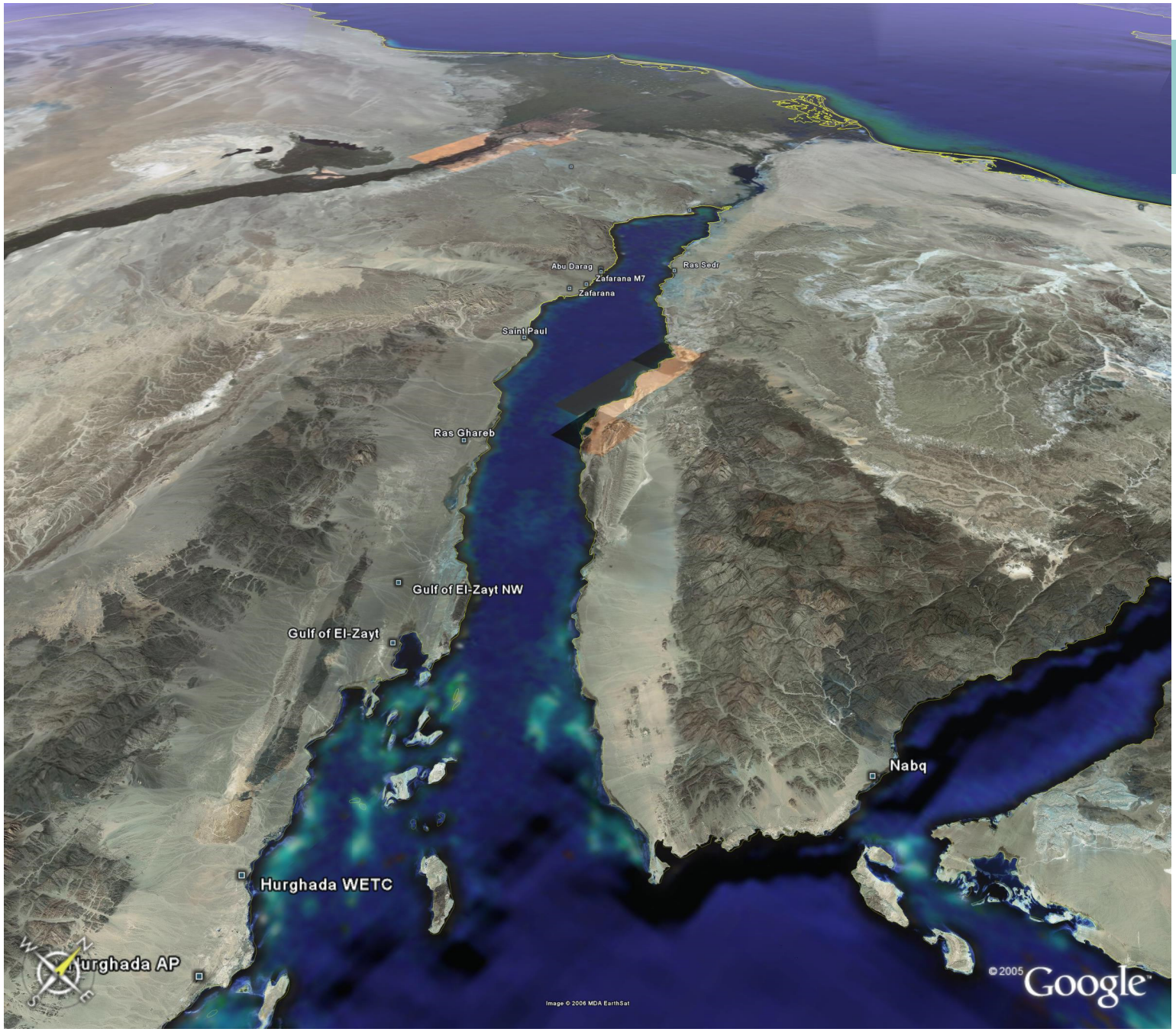
Verification: Western Desert




Abu Darag
Zafarana M7
Zafarana
Ras Sedr
Saint Paul
Ras Ghareb
Gulf of El-Zayt NW
Gulf of El-Zayt
Nabq
Hurghada WETC
Hurghada AP
Image © 2006 MDA EarthSat
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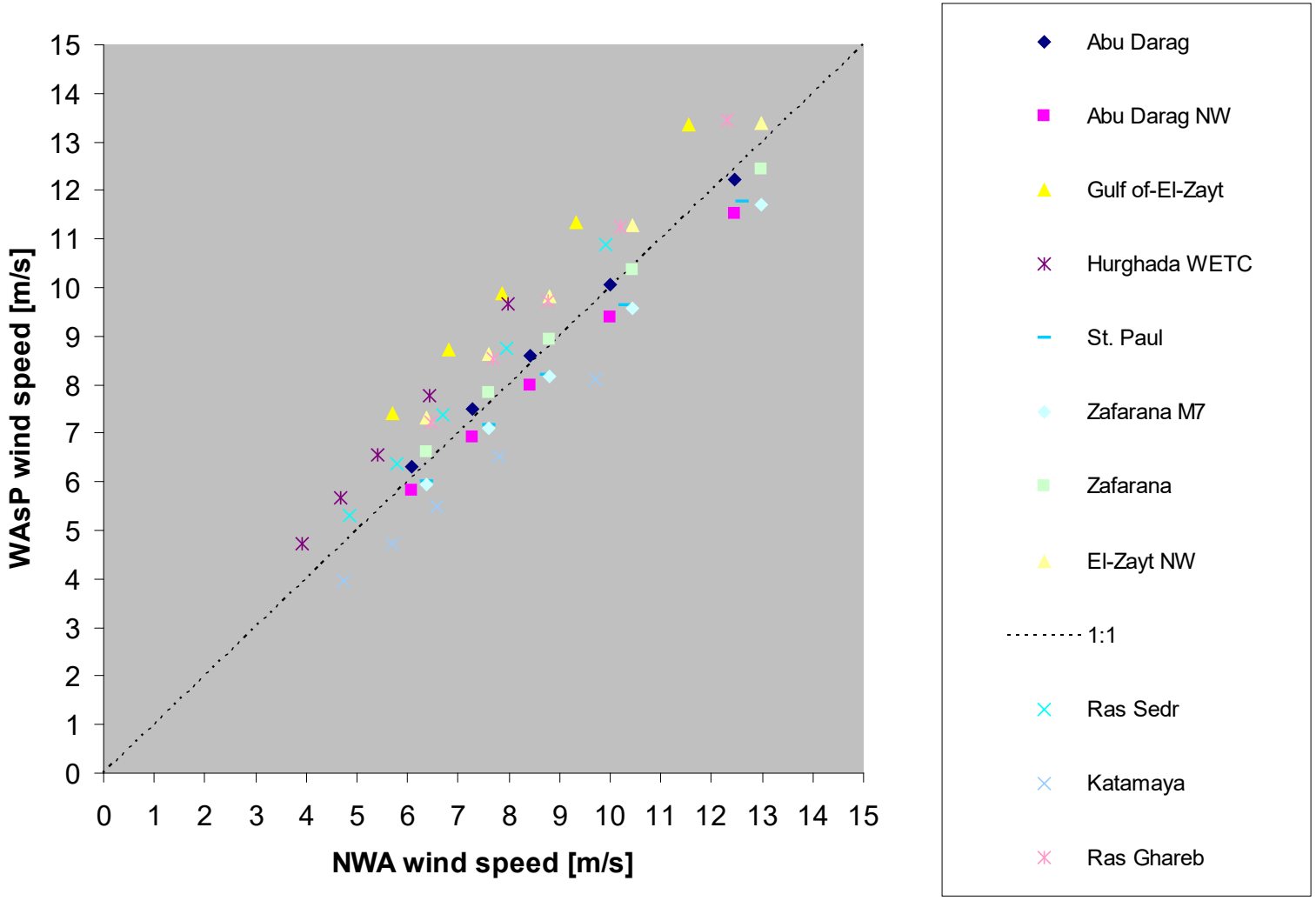
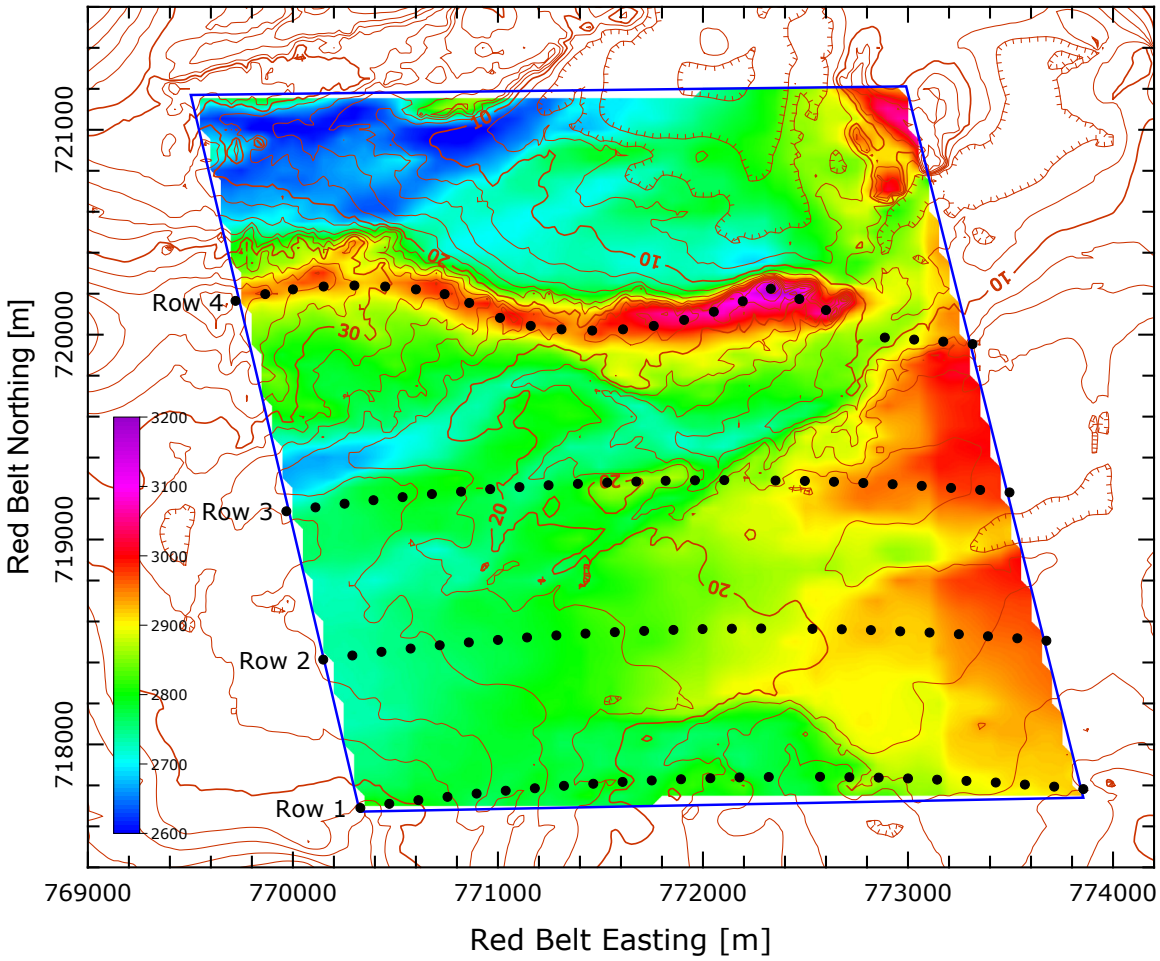
Verification – Gulf of Suez



Wind Atlas for Egypt – application range

1. Egyptian wind resources on national scale
   - Input: numerical wind atlas database (large domains)
   - Output: resource maps, statistics, GIS data,…
   - Purpose: national planning, decision making, master plans,…
2. Regional resource assessments and wind power planning
   - Input: numerical wind atlas database (regional domains)
   - Output: as 1. + predicted wind climates, power productions,…
   - Purpose: regional planning, feasibility studies,…
3. Local resource assessments and wind farm planning
   - Input: observational wind atlas data
   - Output: as 1. + predicted wind climates, power productions,…
   - Purpose: planning, feasibility studies, project preparation,…
   - Bankable ressource assessments close to met. stations

Detailed wind resources at Zafarana



A complete package…

- Wind-climatological inputs
  - Observational wind atlas (30+ stations)
  - Numerical wind atlas (all of Egypt)
- Topographical inputs covering all of Egypt
  - SRTM 3" elevation data
  - SRTM Water Body Data (coasts and lakes)
  - Google Earth satellite imagery (land-use)
- Software tools
  - Microscale modelling tools (WAsP software)
  - Terrain mapping tools (Surfer, Map Editor, Didger)
- Other resources
  - Wind atlases, wind farm planning report, capacity building, …
  - Bird Migration Atlas, EIA reports, guidelines, …

The future…

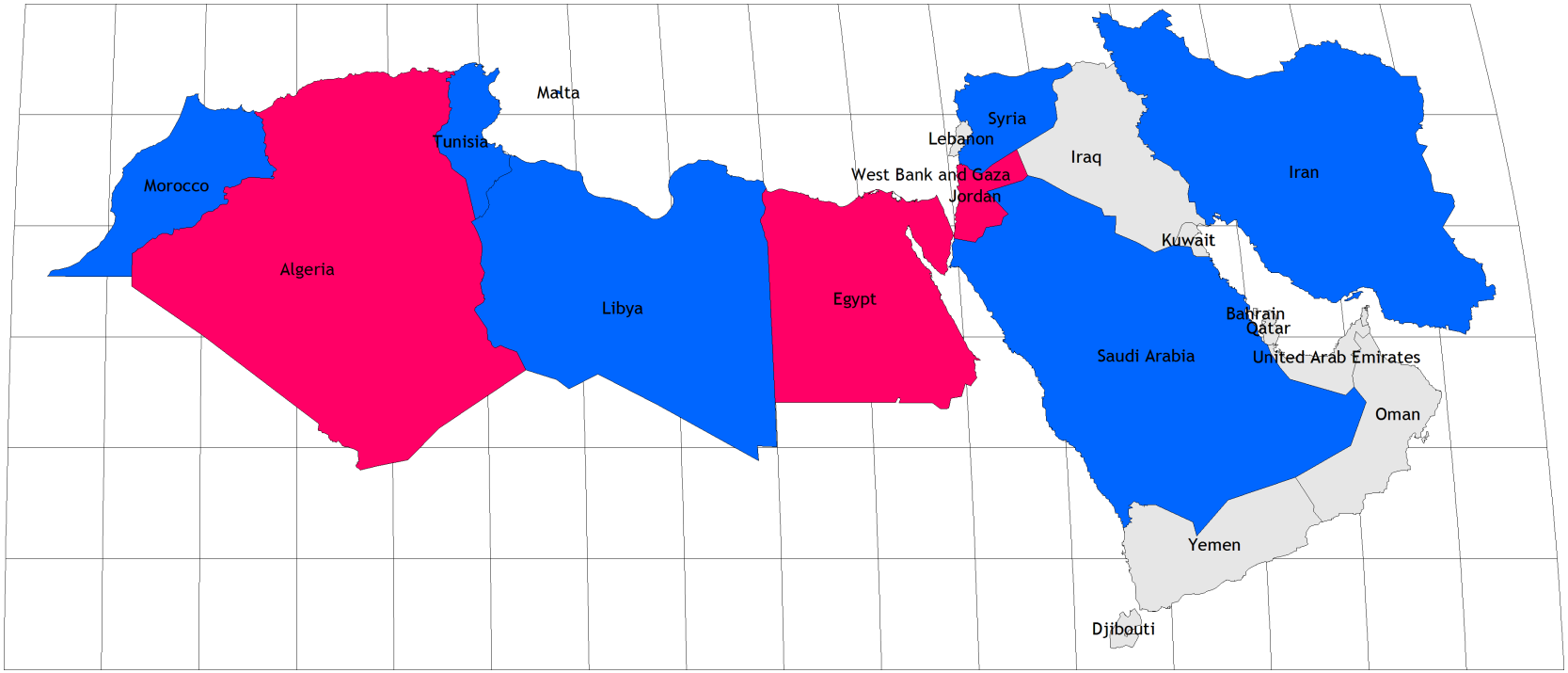
- Numerical wind atlas (KAMM/WAsP methodology)
  - Long-term data (1968-95) – infrequent updating ok
- Observational wind atlas
  - Some reference met. stations should continue
  - New measurement programmes may be initiated
  - Cup anemometers must be rehabilitated and recalibrated
  - Wind Atlas for Egypt can be updated, extended and detailed
- Main conclusions
  - wind ressource assessment, siting and wind farm planning can now be done within hours anywhere in Egypt
  - present approach to wind resource assessment and siting in Egypt may be continued for several years
  - numerical wind atlas methodology can be applied elsewhere

THE END

Thank you for your attention! ☺

(slide by Magnus, 10 years old)

MENA Region overview



- 3 countries with national wind atlases: Algeria, Egypt and Jordan
- 7 countries with some wind resource assessment and siting activities
- 10 countries where no information was available (to me at least)
  - if you have any other or more information I'd like to know…